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RICE IN MALAYA.

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Introduction.

THE importance of cereals as the most valuable of economic crops has been fully recognised from earliest times. History tells us of their cultivation more than 4,000 years ago and their significance in the rise and fall of Empires right down to modern times, even the Germans had hopes of victory in the Great War through starvation of their enemies by cutting off food supplies (mainly cereal) in their submarine compaign.

Neither public works nor industrial pursuits of any kind can be carried on without ample supplies of the "staff of life" for our toiling masses. It may be remembered that the problem of obtaining adequate quantities of rice and other food-stuffs for our people greatly perplexed this Government during 1917 and 1918 when attention was directed to the forced restriction on the importation of food-stuffs into this country due to the war and the consequent lack of shipping, and strenuous efforts had to be made to encourage local production.

Rice was regarded as the most important crop in China in 2800 B.C. (1) and it is now the staple food of over 60% of the population of the world (2) and this percentage is likely to increase because, under suitable conditions rice is cheaper to produce than any other cereal. In Malaya over 99% of our population depends entirely on rice for their subsistence (3) and yet the country only produces approximately two-fifths of our annual consumption. Furthermore, only 16% of the population is engaged in rice cultivation. This is an undesirable state of affairs, as will be readily acknowledged by all who resided here during the rice shortage which was felt so keenly a few years ago; it is consequently one of the prime duties of the Government to encourage the local production of rice, and efforts are being made in this direction. Much is being done in a quiet way by (*a*) District Officers who aim at getting all suitable land in their districts planted up with

1. Commercial Products of the World—Freeman & Chandler.
2. Philippine Agricultural Review, Vol. XIV, No. 1., 1921.
3. Federated Malay States, Census Report, 1921.

rice each season, (*b*) the Irrigation Department in finding irrigable areas and establishing water supplies for them and (*c*) the Agricultural Department in carrying out experimental research with the object of improving methods of cultivation of padi and increasing the yield of crops by the breeding and distribution of selected seed. Although the Malayan Rice Industry is here dealt with in a general way yet the main object of the author is to place on record the progress made with the experimental work conducted during the past six years by the Botanical Division of the Department of Agriculture,

I.—Distribution and Areas.

The rice-growing areas of Malaya are scattered throughout the Peninsula as depicted in the attached distribution map, but considerably more than half the total area is found in the States of Kedah and Kelantan where 80% of the population is Malay. In Singapore and the Dindings there is practically no cultivation of rice, and of the Federated Malay States, Perak is the only large producer. On the western side of the Peninsula, the chief padi areas are confined to the flat coastal lands of Kedah, Province Wellesley and Malacca where the crop depends entirely upon rainfall, and to the Krian district of Perak where the land is irrigated. On the East Coast the bulk of the crop comes from inland, the water-supply being dependent on seasonal rainfall which raises the river levels thus flooding adjacent rice land. Table I shows the areas, percentage of entire area and area in acres per head of population under rice in each State in 1921, and total area under rice (wet and dry) in Malaya.

Province or State.	Area in acres.	Area under rice.	% of total area.	Population 1921.	Area under rice per head.
Kedah	2,334,720	174,060	7.4	338,558	.51 acre.
Perlis	292,000	31,000	15.3	40,087	.77 „
Prov. Wellesley	179,460	33,500	18.33	130,341	.26 „
Penang Town	6,080	nil.	nil.	123,069	nil.
„ Country	63,750	6,030	8.6	39,075	.15 „
Dindings	117,120	720	.6	11,850	.06 „
Perak (including Krian)	5,040,000	119,505	2.3	599,055	.2 „
Krian	204,490	55,000	27.	85,941	.64 „
Selangor :—					
K. L. Town	11,000	nil.	nil.	80,424	nil.
Sel. Country	2,037,000	18,410	.9	320,585	.06 „
Negri Sembilan	1,632,000	30,400	1.9	187,762	.16 „
Pahang	9,152,000	30,025	.3	146,064	.2 „
Malacca Town	3,240	nil.	nil.	30,671	nil.
„ Country	460,400	27,622	5.9	122,851	.22 „
Singapore	145,000	nil.	nil.	425,912	nil.
Trengganu	3,840,000	10,800	.28	153,765	.07 „
Kelantan	3,756,800	175,050	4.66	309,300	.53 „
Johore	4,800,000	13,200	.27	282,234	.05 „
Total	33,870,570	669,262	1.98	3332,603	.204 „

Reckoning on an average production of 250 gantangs per acre per annum (which is higher than the actual average) 5 acres of land under rice per head of population is necessary to render the country self supporting.

This satisfactory state of affairs is only achieved in Krian, Kedah, Kelantan and Perlis where Malays predominate by a large margin and where the above mentioned average yield is approximated. Throughout the rest of the country the population includes masses of immigrant Indian and Chinese coolies employed on the estates and mines, who have no chance of growing their own rice and are dependent on supplies imported from Burma and Siam.

The average yield for the whole country (wet and dry padi) is only 203 gantangs (gallons) and only one-fifth of an acre is cultivated per head of population whereas at the average rate of production it would be necessary to cultivate .62 acre per head of population in order to render the country self-supporting. This matter will be discussed later in a chapter on *Economics*.

The area under rice varies slightly from year to year in each State, the variation being chiefly dependent on rainfall at or just prior to the sowing time, and the market price for padi, though other factors sometimes also influence cultivators. For example, the rice shortage and consequent high prices greatly stimulated production in season 1918-19 and the present depression of the rubber industry is also having a similar effect. Rice lands which have been abandoned for years are now being brought into cultivation again, and there is a demand for good new land.

The distribution of rainfall is, however, the chief cause of variation for it affects crops in all stages of growth. Drought occasionally renders it impossible to sow rice nurseries. Again young healthy plants may wilt and die because of dry weather early after the planting season. Sometimes large areas of newly planted land are devastated by floods whilst heavy crops are often seriously diminished by continued rains at harvest. Thus, the Krian crop which promised good results just before harvest 1921 was extensively damaged by continuous rainy weather with a consequent loss of 30% of the crop which was estimated at 15,500,000 gantangs before harvest, so that it is hardly possible to estimate with accuracy the value of a crop until it is safely garnered.

Table II shows the variation in area under rice in the main rice producing districts of Malaya during the last 7 years.

TABLE II.

Area under Rice in Seasons 1915-1922.

District.	1915-16.	1916-17	1917-18	1918-19	1919-20	1920-21	1921-22	Average.
								Acres.
1 Krian	52,294	50,606	48,546	50,070	52,834	54,373	54,870	51,942
2 Kuala Kangsar	6,899	5,965	11,029	12,262	16,862	17,978	17,620	12,673
3 Malacca	27,520	27,455	26,640	29,230	27,265	28,835	26,409	27,622
4 Kota Bharu	..	..	..	..	115,000	148,000	124,00	129,000
5 Pasir Puteh	..	..	..	..	27,000	43,000	44,000	38,000
6 Penang	5,960	5,890	6,210	6,465	6,335	6,170	5 180	6,030
7 P. Wellesley	33,600	30,540	26,800	32,740	26,238	41,000	31,000	33,131
8 Lower Perak	4,400	2,082	4,138	9,894	13,952	11,836	10,724	8,146
9 Kuala Pilah	13,823	14,118	13,898	14,057	13,778	14,2 2	14,609	14,069
10 Rembau (Sub-district.)	4,374	4,711	4,348	7,281	7,758	7,635	7,462	5,158
11 Pekan	3,424	3,910	5,005	5,244	6,300	5,818	3,767	4,781
12 Upper Perak	5,753	4,142	5,430	5.904	7,340	9,360	5.479	6,201
13 Larut & Matang	9,252	8,918	9,874	10,469	12,899	13,401	13,864	11,239
14 Batang Padang	1,394	1,145	2,435	4,066	11,414	9,503	8,281	5,462
15 Kuala Selangor	4,172	2,505	1,290	1,854	6,215	8,764	11,331	5,161
16 Seremban	3,448	3.134	3.292	3,313	3,757	4,144	5,248	3,762
17 Tampin	5,998	5,898	5,585	8,600	9,049	8,982	8,992	7,586
18 Kuala Lipis	6,973	7,011	7.391	7,052	7,855	7,734	7,628	7,378
19 Raub	4,367	4,073	4,709	3,424	5,837	4,798	6,197	4,772
20 Temerloh	8,089	8,699	8,957	7.693	10,139	8,935	10,891	9,057
21 Kota Star	..	..	..	..	69,630	68,380	67,450	68,486
22 Kubang Pasu	..	..	..	..	19,284	..	20,929	20,106
23 Muar	..	..	..	..	4,530	5,260	7,890	5,893

Though by far the larger area under rice in Malaya, is devoted to wet rice cultivation, the area under dry land rice is considerable amounting to 43,130 acres annually.

Table III. shows the chief dry rice producing districts and the variation in area in acres in each year for seven years.

TABLE III.

Area under Dry Padi in Acres-Seasons, 1915-1922.

	Upper Perak.	Larut and Matang	Kuala Kangsar.	Kinta.	Batang Padang.	Lower Perak.	Kuala Selangor.	Ulu Selangor.	Kuala Lipis	Pekan.	Padang Trap.	Muar.
1915-16	512	298	370	1152	776	3220	3822	650	2868	1293	600	—
1916-17	826	70	345	191	856	1732	2155	178	2819	1294	1000	—
1917-18	1372	190	769	970	2190	3107	933	196	2502	1220	1400	—
1918-19	1963	442	952	2576	3200	7811	1513	1016	1943	1167	2300	1250
1919-20	3421	2928	4258	6745	10194	11607	1515	2138	2789	1506	2960	1980
1920-21	5000	3015	3300	6398	8415	9604	624	2702	2701	2155	3300	1500
1921-22	1330	1563	2665	4861	7638	8058	336	2420	2193	803	3201	2476

Variation in the area under dry rice is more marked than in the case of wet rice, because land suitable for dry rice cultivation is more abundant and more rapidly available than for wet rice, hence the area under dry rice is more rapidly influenced by changes in the market price of rice than is the case wifh wet rice areas. Also dry rice cultivation is possibly more dependent on rainfall than wet rice since the latter is unusually grown in localities there percolating water collects, in contrast to the dry rice areas which are more commonly found on sloping land and thus depend chiefly on the the precipitation of rain.

II.—IRRIGATION.

Irrigation on a small scale is a common practice in Malaya, the Malays displaying remarkable aptitude in diverting small streams so as to get the maximum utility from them. Temporary weirs of logs, bamboos, matted sticks and earth are commonly constructed to deviate the water of the larger streams and rivers into distribution channels for irrigating fairly large areas such as those along the Perak River. In Pahang and Kelantan where practically all the padi land is situated on the alluvial flats following the river courses, the water-supply depends on the overflow of the banks of the rivers during the more or less regular rainy seasons.

Water-wheels and other ingenious mechanical contrivances for raising water are employed to irrigate small areas as in Upper Perak, Kuala Pilah and elsewhere. Under special conditions, terracing is practised, the edges of terraces being thrown up into small well compacted ridges in order to contain the water which is distributed by gravitation and percolation.

Permanent adjustable dams are frequently erected in the streams or in specially constructed canals for flooding large flat areas as in Malacca, while fixed bunds have been made in several flat areas where the water supply is entirely dependent either on rainfall as for instance in Sabak and Kedah, or on the overflow from rivers as at Pekan. There are numerous small low-lying areas which are converted into swamps in the wet weather by their natural configuration where no form of irrigation is necessary, but crops on this type of land are precarious.

In certain tin-mining districts, Gopeng for example, water in supplied over long distances to very small blocks of padi land in miniature aqueducts constructed from various materials such as large bamboos, split coconut or nibong stems. When the source of supply is adjacent and has only to be raised, several ingenious methods are employed. An empty kerosine oil tin with the top removed or a closely woven basket is held by ropes worked by two labourers who swing the tin (or basket) into the water and continuing the swing upwards empty it at the higher level into a tank or channel from which it flows to the field which is to be irrigated. When the supply is derived from a percolation well or when there is a lift of 15—20 feet a bucket is suspended from one end of a long beam which is pivotted to a post near the other end, so as to revolve through a vertical plane. The shorter end is weighted so as almost to counterbalance the weight

of the full bucket and the longer arm, and one coolie adds the extra pull and empties the bucket each time it reaches the desired level.

The Government is endeavouring to encourage the extension of padi cultivation by placing more irrigable land at the disposal of cultivators and table IV, kindly supplied by the Irrigation Department, shows what schemes are projected and area of land which each scheme is expected to irrigate.

TABLE IV.

		Approx. Acreage.	
		Acres	
1	Krian in North Perak	56,000	Completed
2	Gua Badah „ Lenggong	1,000	„
3	Kenas „ Kuala Kangsar	2,000	Under Construction
4	Pulau Tawar „ Jerantut	1,800	(Nearly Completed)
5	Batu Kikir „ Kuala Pilah	4,600	Surveyed
6	Terachi „ „ „	not reported Acres	Being surveyed
7	Dong „ Raub	250	Partly surveyed
8	Lawin „ Grik	300	Surveyed
9	Ibul „ Lenggong	200	„
10	Briak „ Bukit Merah	5,330	Surveyed & partly drained
11	Lower Perak „ Lower Perak	142,000	Preliminary survey
12	Bota „ „ „	4,000	Surveyed

In addition to the work outlined in Table IV. the Irrigation Department performs many minor works for improving existing natural and artificial water supplies and considerable assistance is rendered to settled cultivators every year by District Officers and others for the upkeep of water-courses, bunds and dams throughout the country.

Moreover, in certain districts where irrigation is possible the District Officers are endeavouring to extend or introduce the cultivation of padi, by offering land to probable settlers on particularly attractive terms. Thus one large area of about 100,000 acres in the Kuala Selangor district which is still under jungle and where the water supply in abundant has been reserved for padi cultivation and settlers are only given titles to land on condition that they plant a definite amount of padi annually.

This policy might be more widely adopted and all land suitable for rice cultivation and where water is readily obtainable might be offered to cultivators for padi cultivation on particularly attractive terms so as to induce Malays to settle and grow their own crops.

The importance of irrigation for wet rice cultivation cannot be over emphasised since the water supply is the chief factor which determines between good and bad crops, on average land. The amount of irrigation required depends on the physical characters of the soil and the variety of padi planted.

Deep soils or soils without an underlying layer of impervious heavy clay or a hard subsoil require more water than soils which possess either of these foundations. The ideal padi soil is a fairly rich loamy clay some 4 to 6 inches deep, with an impervious layer of heavy clay underlying it. Such a soil, provided that it is fairly level, is easily irrigated since the impervious layer makes it possible to inundate the land for a long period with the minimum supply of water.

On areas where irrigation is not controlled systematically there is a tendency to maintain too great a depth of water in the rice fields while even in areas where the irrigation is controlled too much water is a more frequent occurrence than too little and consequently much water is wasted. Of course, on large areas discrepancies of land level sometimes render it impossible to keep the depth of water uniform, since in order to irrigate slightly elevated patches, the deeper water in the depressions is unavoidable. Even when due consideration is given to this point, too much water is frequently maintained on the land for padi only requires from four to six inches of water during its period of vegetative growth. The length of this period, ofcourse, depends on the variety of padi grown, but whatever the variety it is advisable that the land should be drained off completely six to eight weeks before harvest. Irregularities in the depth of irrigation water interrupt the uniformity of the ripening of padi to some extent and hence unit areas should always be levelled as thoroughly as possible, for the purpose of irrigation. Irrigation of suitable land would go far to extend the present area under rice in Malaya, for wherever good average land is adequently irrigated. it would attract settlers and good crops would be produced from areas now lying idle.

III.—SOILS.

The wet rice soils of Malaya are confined to the alluvial tracts on the west coast and all along the banks of the rivers throughout the Peninsula. Geological and biological evidence favour the view that most of the coastal rice land, figuratively speaking, is land recently reclaimed from the sea by gradual elevation (1) portions of it still being within tidal influence. The dry rice soils mostly follow the rivers but are situated higher up the valleys, in low foot hills and even on the steeper hills where rich loams are encountered.

Soils are classified by Hilgard (2) according to the amount of clay which they contain and rice is only grown satisfactorily in Malaya on clay loams (15-25% clay) clay soils (25-35% clay) and heavy clay soils (35% clay and upward) and its growth is so seriously arrested when the proportion of sand increases beyong 35% as to render the production uneconomic.

Table V. (compiled from records prepared by the Chemical Division of the Department) shows the results of chemical and mechanical analysis of typical rice soils.

TABLE V.

Chemical Analysis.

No.	Moisture.	Loss on heating	Potash.	Available Potash.	Phosphate.	Available phosphate	Lime.	Magnesia.	Nitrogen.
1	5.1	12.85	.540	.0794	.0648	.00454	.13	.16	.209
2	2.3	8.1	.555	...	.041	...	.117	.176	.246
3	4.7	12.1	.55	.0388	.06	.0084	.19	.52	.386
4	2.3	11.3	.403	.0186	.104	.0094	.04	.17	.118
5	3.0	11.6	.172	.0084	.0514	.00949	.1982	.088	.201
6	1.54	9.1	.139	.0058	.029	.00135	.089	.044	.20
7	2.1	8.2	.241	.0054	.045	.0048	.15	.24	.123
8	2.0	8.2	.154	.00845	.0287	.00187	.128	.036	.081
9	.98	5.7	.0245	...	.0156	...	.07	.15	.17
10	4.7	32.0	.215	.0601	.0713	.01180	.12	.25	.639

Mechanical Analysis.

No.	Locality	Humus	Clay	Fine silt	Silt	Sand	Class of land
1	Krian	4.0	57.7	20.9	15.3	2.0	1st.
2	Kedah	...	28.2	58.1	10.5	3.2	1st.
3	Kedah	...	31.1	31.7	27.2	10.0	1st.
4	K. Kangsar	...	26.2	50.4	15.3	7.1	1st.
5	Jelebu	4.0	17.5	32.8	16.3	29.4	2nd.
6	Kuala Pilah	...	17.6	28.1	16.6	37.7	2nd.
7	K. Kangsar	...	18.6	27.4	14.0	40.0	2nd.
8	Jelebu	1.6	19.1	30.2	7.3	41.8	2nd.
9	K. Kangsar	...	6.9	10.2	14.0	68.9	3rd.
10	Krian (peaty)	12.8	28.9	34.6	15.6	8.1	3rd.

In the above table of analyses the soils nubered 1 to 4 are typical of the best rice soils in Malaya in that they contain a high percentage of clay and fine silt and very little sand. They are all low-lying heavy clays rich in potassium and phosphorus and other essential plant nutrients and are capable of producing at least 500 gantangs of padi in an average season.

Soils numbered 6 to 8 are placed in the second class as crop producers on account of their lower percentages of clay, higher amounts of sand and smaller quantities of potash constituents. These soils, under the best forms of irrigation do not produce over 450 gantangs per acre. The general average is smaller than this and under ordinary conditions 250-350 gantangs may be take to represent an average crop.

Soil number 9 is useless for padi cultivation because of its very high proportion of sand and its very low supply of plant food. This type of soil is only cultivated when no other land is available or in a season of rice shortage when prices are high.

Soil number 10 is rendered uneconomic for padi on account of its peaty nature, though in other respects its composition would place it in the first class. Sand and peat are detrimental to the growth of the rice plant, the former because of its deficiency in plant food and its failure to retain moisture and the latter because of its humic and other organic acids which kill the young roots. Three to four inches of surface peat convert otherwise first class land into third class. Experience and analysis show that physical texture and the condition of the soil are more important factors from the point of view of rice production than chemical composition. All clay soils are rich in potassium. The supply of nitrogen as revealed by analysis is abundant, moreover considerable quantities of this element are brought to the land by the irrigation water in the form of nitrates and ammonia; also further quantities accumulate between the padi seasons as a result of the growth of weeds which is subsequently cut down and ploughed under or permitted to rot on the surface of the soil.

Of the three most essential elements phosphorus is present in the soil in by far the least amount, but at the same time, even soil number 9 which is the poorest in this constituent, could supply sufficient to meet the requirements of at least 20 crops of rice, reckoning that an average crop of padi takes 9.53 lbs. of phosphorus calculated as phosphate (3) from the soil. Thus it can be seen that as far as the chemical composition of the soil is concerned, all our ordinary soils contain the food requirements of the padi plant.

On the other hand the effect produced by differing amounts of sand, clay and peat in the soil are striking, so much so that the amounts of each afford a ready guide to the classification of soils as first, second or third class as rice producers. The following table shows roughly the limits of variation in the percentage of these constituents in the different classes of rice soils.

TABLE VI.

Class.	Humus.	Clay.	Fine silt.	Silt.	Sand.
1st.	3 to 7	25-65	20-60	10-25	2-10
2nd.	2 to 5	15-30	25-40	15-35	20-40
3rd.	1 to 3 (peat excepted)	5-20	5-20	15-40	35-70
Peaty.	over 10	15-40	20-50	5-15	0-10

The above table can be used with confidence in adjuding the suitability of any soil for the cultivation of padi, provided that due consideration is given to the question of water supply.

1. Geology of South Perak North Selangor and the Dindings — Scrivenor and Jones, Geological Department F.M.S., 1919.

2. Soils — E. W. Hilgard, 1907.

3. Some Rice Soils — M. Barrowcliff — Agr. Bull. F.M.S , Vol I, No. 12, 1913.

IV CULTIVATION.

Soils vary from place to place and since the nature of the soil determines the method of cultivation, methods vary in different States and districts. The main points of variation are (1) the preliminary preparation of the soil, (2) the preparation of the nursery, (3) the degree of tillage, (4) the practice of manuring, (5) the methods of sowing, (6) the number of transplantations, (7) the amount of weeding and (8) the method of harvesting.

Broadly, there are two types of cultivation, (a) Wet rice cultivation and (b) dry rice cultivation, though methods vary within these two classes according to local custom and the nature of the soil.

(a) *Wet Rice* :—Generally the harder lands are ploughed or 'chankolled' as soon as rains render them sufficiently soft, then they are freely watered, cleared of weeds by a buffalo-drawn rake, and rolled into a homogenous slime, the amount of ploughing, rolling and raking depending on the condition of the soil, the availability of cattle and the industry of the cultivator. Frequently, the masses of rank grasses which have been produced during 4 to 5 months of fallow have to be cut down before ploughing and are then allowed to rot on the surface of the soil. This practice makes ploughing less arduous, adds humus to the soils and greatly benefits the crop. All the implements used are primitive in design and construction but very effective when diligently used.

The native plough is a much maligned implement and is held responsible by many people for the unsatisfactory padi crops. This is not the opinion of the author. Poor crops are more often due to dearth of buffaloes which results in too scanty tillage of the soil. The plough possesses the advantages of being light and of easy draught and together with its handle, is carved out of a single piece of hard wood and shaped so as to turn the top 4 to 6 inches of soil. The beam is fixed immoveably to the plough and is more often arranged for fitting to a pair of bullocks or buffaloes, though a single draft arrangement is also common. The roller consists of a cylindrical hard wood beam some 14 inches in diameter and 4 to 5 feet long with stout cylindrical flanges protuding some 4-5 inches at each end, to which rattan ropes are fixed for hitching the roller to the draft animals. Along the length of this beam, six triangular grooves about 2 inches deep are carved, the uncarved portions thus forming ridges which bury the few weeds left after raking, break the clods and pulverise the lumps of clay, so that eventually the soil is brought to a very even tilth. The rake is used to clear up the weeds and pulverise the soil. Various

manurial materials, usually insufficient in amount, may be incorporated with the soil after ploughing but before rolling, the most common fertilisers being bat guano, bonemeal, ashes and cowdung, according to their availability and cost. The subject of manures will be discussed later. In these harder soils the use of "dry" nurseries is more common than that of "wet" nurseries, that is, the nursery is situated on a piece of land which is not liable to inundation. The nursery soil is usually dug over and thoroughly cultivated to a depth of 8-10 inches though sometimes the operation is limited to cleaning the top soil only, and the seed, either dry or after 24-48 hours soaking in water, is thickly broadcasted and covered by sweeping the surface with tree branches or by ploughing lightly. Frequently, the nurseries are manured with ashes, burnt earth, or bonemeal.

Failing showery weather, the nursery is watered at least once daily, and continued, if possible, until the young plants are between 40 and 50 days old when they are ready for transplantation into the fields. Before this is done, the nursery is heavily watered to soften the soil and then the seedlings are pulled up, their roots being thoroughly cleared of nursery soil. Following this they are tied in bunches which are kept moist and cool, ready for planting. Sometimes the bunches of seedlings are placed in a manure paste, commonly consisting of guano, cowdung or bonemeal, or mixtures of these ingredients ; a practice which distributes the manure very evenly, but the total amount of manure used is small.

In some of the coastal districts rice lands consisting of very heavy clays become so soft and plastic when inundated with water that ploughing and rolling can be dispensed with. Here the only cultivation necessary is a thorough clearing away of the heavy growth of weeds and grasses which usually covers such lands to a depth of 3-4 feet in the fallow season.

The irrigated area in the Krian district, comprising 55,000 acres, is the largest block of land in which this form of cultivation can be practised with success, but it is also applied in the coastal parts of North Kedah, in many of the valleys in Perak and in the southern parts of Province Wellesley. The method of cultivation in Krian has been described in detail in Bulletin No : 32 (1) of this Department and that method applies equally to most of the softer padi lands in the country except in the matter of destroying the weeds and grass. In Krian, and several other areas, fallow vegetation is cut down by means of a " tajak " (a short heavy scythe-like instrument which the cultivator swings from above his shoulder) at the surface of the soil as soon as water covers the land to a depth of a few inches. The cut grass is permitted to rot on the land for 4-6 weeks and is then removed to form the divisions (" batas ") which separate each man's holding.

In locatities other than Krian, buffaloes are sometimes driven on to the land to trample the grass into the soil, where it rots and adds greatly to the organic matter in the land. For most of the softer type of soils wet nurseries are employed, though they are frequently used for supplying some of the harder

areas also. In the preparation of a "wet" nursery on the softer inundated lands, the fallow grass is cut and piled up into a long strip usually 3-4 feet wide, until the pile stands about an inch above water level. On this grass foundation sufficient clay is plastered to make the whole into a compact bed on the top of which a thin layer of mud rich in humus is finally laid to complete the seedbed. Thus, should the level of the water in the fields rise, the nursery, rendered buoyant by its grass foundation, floats and maintains its surface above water level. The construction of a 'wet' nursery in the harder lands is a more arduous task as the soil has to be throughly cultivated, then irrigated and puddled to a fine mud before the seed can be sown. For both types of seedbed the seed is commonly soaked in water for 1—2 days and then maintained in a moist condition for a further period of 1—2 days until germination has commenced. It is broadcasted thinly on the nurseries intended for planting the harder soils, whereas for sowing the softer lands the seed is sown thickly and two transplantations are usually required. For the production of good crops of padi in the softer soils, transplantations are found necessary, since otherwise the vegetative growth is rank at the expense of the grain. The amount of seed required to plant an acre of land varies with the fertility of the soil. On the best land three "gantangs" (gallons) are sufficient, the quantity making ample allowance for damage due to pests, while medium land requires 4 to 5 gantangs and poor land as much as 6—7 gantangs per acre. In some areas nurseries are dispensed with, the seed being broadcasted directly in the fields after ploughing and rolling. This method is in vogue only where the water can be run off the fields a few days after sowning unsoaked seed and run on again after the young plants are several inches high.

(*b*) Dry Rice.

Dry land rice is a more precarious crop than wet rice because it is absolutely dependent on rainfall which must be evenly distributed for about 3 to 4 months if a satisfactory crop is to be reaped. Rain is essential to germinate the seed and start the growth of the young plants, which, once thoroughly established, can thrive under conditions of so small a water-supply as would ordinarily spell complete ruin to the growth of "wet padi" varieties. There are, however, exceptional types which have been found to produce economic crops when grown either as wet or as dry padi.

Two methods of cultivating dry rice are in vogue.

(*a*) "Ladang," "Tanah tugal," Huma" or hill cultivation.

This primitive and easy method of exploiting virgin soil consists, in its simplest and most wasteful form, of the utilization of the rich newly burnt jungle to the production of two or at the most, three annual crops of cereals. Generally the sides of low hills, or undulating jungle lands, are chosen for this type of cultivation. Sometimes land utilised several years previously and carrying a thich growth of secondary jungle, is used again. The land is first cleared of its thick growth of underbush, then the larger trees are felled and the whole

burned. After the first burning the remaining branches are piled against the larger tree trunks and fired a second time. These operations are usually timed so as to be completed just at the beginning of the rainy weather. After the first heavy rains have fallen the seed is sown. The actual method of sowing the seed as the Malay term "tugal" implies, consists of dropping several (5-15) seeds into shallow depressions made by a stake with a rounded end, the seeds being subsequently lightly covered with soil by the foot of the sower. The holes are usually spaced about one foot apart each way, the seeding rate per acre being 1-3 gantangs of padi according to the skill of the sower. Sometimes the seed is broadcasted requiring about ten "gantangs" of seed per acre. The better class of cultivators weed their clearings once some 6-8 weeks after planting, and rarely twice. whereas the aborigines (Sakai) never weed their clearings by any chance. Many "ladang" cultivations are almost intensive in their nature being sown with the quicker growing maize (*Zea mays,*) or the "menjelai" (a soft shelled form of Job's Tears (*Coix lacryma jobi*) crop at the same time as with rice. These catchcrops rapidly develop long erect stems with leaves which produce little shade effect on the padi. Under good conditions this type of cultivation can be made to yield up to 350 gantangs of padi to the acre as a first crop on newly cleared jungle land, the yield for a second crop being limited to about 250 gantangs. A third crop rarely produces more than 150 gantangs per acre. Only on specially rich soil is a fourth crop attempted and the yields mentioned, though produced, are rarely obtained, because of the incidence of various pests, particularly birds, pigs and rats.

Though this form of cultivation is primitive in character yet it has been evolved by long experience. The underlying principles of the practice are sound from certain points of view because two or three crops of padi can be produced with little labour beyond the initial felling of the jungle; the competition of noxious weeds is reduced to a minimum and injurious pests and diseases are destroyed.

Again, the partial sterilization of the soil which results from the burning of jungle on newly cleared lands is no doubt beneficial, but whether this temporary increase in fertility is commensurate with the tremendous loss of valuable organic matter destroyed by fire is very doubtful, at most, the practice is economically unsound in that large areas of valuable forest and fertile soil are destroyed or lost for the low value of two or three small crops of padi. On the other hand on old established holdings where the fertility of the soil is much reduced and where there is no readily available source of organic material to supply the requirements of the padi plant, then the practice of partial sterlization is certainly beneficial to the succeeding crop.

Referring to the effects of heating soils it has been shown by Russell and Hutchinson (2) that partial sterilization of the soil by moderate heating results in a great increase in the amount of ammonia present in the soil, due to the enormously increased bacterial flora. Soil protozoa, which succumb to the heating of the soil more readily than the bacteria on which they feed, are so greatly depleted in number that, after partial sterilization, they are unable to limit the numbers of bacteria, which multiply more rapidly than do

the protozoa. Hence there is a temporary increase in the numbers of bacteria, until the normal number of protozoa is restored and this temporary increase in the number of bacteria results in an excess of ammonia because of the increased decomposition of soil substances by bacteria. Not only is the productivity of the soil increased by partial sterilization, but there is also an increase in the rate of growth of plants grown in such soils, as Russell and Petherbridge (3) have demonstrated." These phenomena have only been discovered in the last decade and yet the hill padi planter has taken advantage of them, probably, for hundreds of years, in the practice of burning the scrub and timber on his clearings and thus unconciously increasing the productivity of his land by the partial sterilization which such heating of the soil affords.

It has been shown by Thompstone (4) that in place of partially sterilizing soils by heating them and thus rendering them temporarly productive, continuous profitable cropping can be effected by the application of lime and organic manures combined with rotations of crops, but much propaganda is necessary before Malays are likely to be induced to modernise their methods of "ladang" cultivation. particularly as land is at present abundant and food relatively cheap.

(*b*) Tenggala or plough cultivation :—

This method of dry rice cultivation might have great possibilities if our Malay population was of a more industrious disposition as it can be applied to almost any type of flat or gently undulating loamy land, its essentials, like cereal cultivation in Europe depending on thorough tillage of the surface soil and rainfall. The areas at present under this method of cultivation are almost limited to the flat alluvial stretches following the meanderings of the Pahang River, but they might be vastly extended should the necessity arise, provided that a sufficient number of buffaloes was available or it was found practical to provide and work motor ploughs, along communal lines. The land, which in fallow, supports a sparse growth of grasses and "blukar", (secondary jungle growth) receives scant cultivation partly because of the slackness of the cultivators, but also because the supply of buffaloes for ploughing is often insufficient. The land is cleared of "blukar" including the extraction of the roots. It is then ploughed lightly 3 times, the direction of each successive ploughing being at right angles to the previous one, and finally raked with a coarse buffalo-drawn rake ("sikat") which has much the same effect as a harrow on the soil. This constitutes the entire cultivation which is good as far as it goes except that no manures are distributed or mixed with the soil, and the tilth is not sufficiently deep, being limited to about 4 inches.

The seed, previously germinated, is broadcasted at the rate of 10 gantangs per acre, the land being divided into narrow strips for the purpose of assisting in the even distribution of the seed, which is afterwards lightly covered by drawing branches across the fields or raking lightly or ploughing.

Weeding, which would probably benefit the crop, is rarely practised unless unfavourable weather conditions retard the growth of the rice, thus giving weeds a chance in the struggle for light and food.

The yields derived from this method of cultivation compare favourably with those obtained by the "ladang" method, but the annual diminution in yield is not so marked as in the latter case and a longer succession of paying crops can be reaped than is possible under "ladang" cultivation. "Tenggala" land is usually cultivated for 3 or 4 years in succession and then fallowed for a similar period, though crops are sometimes taken for 5 or 6 years, especially in areas which are enriched annually by floods from the rivers.

The scope for improvement of this method of cultivation is wide, including the introduction of crop rotation with special reference to green manuring which would greatly shorten the fallow period or possibly dispense with it, improved cultural implements, weeding and drilling as compared with broadcasting the seed.

Planting.

The arduous work of wet padi planting is done almost entirely by women and the actual operation is either done by hand or with the assistance of the simple implement called "kuku kambing" (goat's hoof) (1) which is cleverly designed to obviate the prolonged stooping position which hand-planting necessitates. Men usually assist the women-folk to the extent of conveying bunches of seedlings from the nurseries to the fields, pruning the seedlings to check evaporation and subdividing large clumps of seedlings into lots suitable for handling by the women. The women are expert planters, 6 women being capable of planting an acre a day when using the "kuku kambing" The general unformity obtained by them in spacing the plants is remarkable.

Spacing.

The spacing of plants varies with the nature of the soil and the depth of water in the fields. In good land where high tillering is constant, it is usual to allow 1.5 to 2 square feet per hill, each hill containing on the average 3 seedlings. Thus, in first class land in Krian the average planting distance was found to be 15 by 17 inches (5) or 1.75 square feet per hill.

In medium soils the spacing distance is reduced to about 14 or 15 inches each way, and in poor soils, the reduction of space is carried further though it is rarely necessary to set hills closer than 10 inches apart in wet-padi cultivation. When the water in the fields is deeper than one foot or fifteen inches it becomes necessary to space the plants somewhat closer than when shallow water is experienced, because deep water inhibits tillering considerably and if very deep, even kills may young seedlings. Thus, deep water diminishes a crop seriously by reducing the average number of tillers per plant.

Weeding.

Weeding is invariably practised in the cultivation of wet rice, the number of weedings varying from 1 to 3 according to local custom, the fertility of the soil, the depth of water and the disposition of the cultivator. In rich soil one thorough weeding some 6 to 8 weeks after planting is usually sufficient, since the growth of the young rice plants is so rapid that the plants quickly form a heavy canopy under which weeds thrive but slowly and have little effect on the crop. In poor soils, on the contrary, the best results are obtained when the land is weeded twice, since otherwise the growth of weeds tends to overtake that of the rice plants. The stunting effect of shading is quickly noticeable on the latter and in addition tillering is completely inhibited.

Tillering.

When the young plants have been firmly established in the field for about a month they begin to tiller, that is, each plant sends up a varying number of shoots from its base, each shoot eventually forming a flowering head (ear) and bearing fruit. It has been shown (5) that the number of tillers per plant within a variety depends on the fertility of the soil, the distance of planting and the depth of water in the fields so that the economic planting distance varies in different localities according to soil conditions. Under the best possible conditions, a good variety such as 'Seraup' (8 months) may produce as many as 50 tillers per plant, but under good ordinary agricultural conditions, 18-20 tillers per plant is a good average, while in poor soil 2-3 tillers per plant are frequently found. This ability of rice plants to tiller is often useful in breeding work when it becomes necessary to supply vacancies in a planted area of definite dimensions, for the plants can be divided several times without any apparent damage being done to the stock plant, which quickly throws out fresh tillers to replace these excised. Thus a ready method of bud propagation is available at any time should an increase of the planted area of any particular strain be required. This method of propagation has already proved useful in experimental work.

Flowering.

The time which elapses between the planting of the seedlings in the field and the appearance of the flowers varies with different varieties. In Malayan rice, this may vary from 2 to 6 months. The first indication of the flowering period is a pronounced swelling of the stem of the leading shoot, shortly after, the young colourless flowering panicle thrusts itself through the ensheathing leaves, the individual flowers beginning to open about 10 days later. The flowers mature from the top of the spike downwards, a period of about 6 days being necessary to ripen all the flowers on each panicle and each flower only remains open for some 20 minutes. Self-pollination is usually effected before or during the opening of each flower, (5).

1. Observations on the Technique required in Field Experiments with Rice—H. W. Jack—Bulletin 32, Department of Agriculture, F.M.S. and S.S., 1921.

PATANI
K. Telubin
P. Terutau
K. Setul
PADANG BESAR
YALA
K. Tong
K. Menara
P. Langkawi
KANGAR
TANJONG MAS
K. Tabar
TUMPAT
K. Layang
K. Kelantan
A BHARU
ALOR STAR
Kedah River
PATANI
Yen
S. Salar Besar
KEDAH
S. Gurun
Tomoh
K. Semerak
Belong
Belum
S. Merbok
K. Muda
UNGEI PATANI
Saling
Kroh
K. Besut
Tanah Merah
S. S'tiu
PENANG
Gri
Lebir
BUKIT MERTAJAM
PROVINCE WELLESLEY
Kenering
K. Trengganu
K. Ibai
K. Marang
K. Merchang
KELANTAN
Pt. Bu
Durien Pipit
Kg. K. Bram
PERAK
TAIPING
Kati
PORT WELD
KUALA KANGSAR
S. Trong
Tg. Rambutan
K. Dungun
K. Bake
K. Kenetir
K. Kemesek
IPOH
GUNONG TAHAN
Batu Gajah
S. Bruas
DINDING
TRONOH
Kampar
Kemaman
Tapah
TAPAH ROAD
KUALA LIPIS
K. Kemaman
K. Perak
TELBELING
K. Chendar
TELUK ANSON
K. Penggaru
Bagan Pasir
K. Bernam
PAHANG
K. Kuantan
TANJONG MALIM
S. Penor
S. Pahang Lama
Bentong
S. Besar
Tg. Karang
SELANGOR
K. Kubu
MENTAKAB
K. Pahang
Tasek
KUALA SELANGOR
COALFIELDS
TRIANG
KUALA LUMPUR
AMPANG
PORT SWETTENHAM
KLANG
S. Merchong
NEGRI SEMBILAN BAHAU
K. Selat Lumut
K. Jugra
K. Rompin
P. Tioman
K. Langat
SERDANG
K. Endau
GEMAS
K. Sepang
PORT DICKSON
Tg. Tuan
K. Linggi
S. Baru
MALACCA TOWN
K. Kesang
K. Muar
KLUANG
JOHORE
K. Sedili
K. Sedili Kech
S. Sarang Buaya
Batu Pahat
K. S. Batu Pahat
S. Sengarang
S. Tiram
S. Sanglang
K. Puntian
JOHORE BHARU
WOODLANDS
SINGAPORE
SINGAPORE
STRAITS OF MALACCA
SUMATRA
CHINA SEA
DISTRIBUTION OF PADI AREAS IN MALAYA
Scale 40 Miles to an Inch

2. The Effect of Partial Sterilization of Soil on the Production of Plant Food—Russell and Hutchinson—Journal Agricultural Science, Vol. 3, Part 2, 1909.

3. The growth of plants in partially sterilized soils—Russell and Petherbridge—Journal Agricultural Science, Vol. 5, Part 3, 1913.

4. Agriculture in the Shan States—Thompstone—Agricultural Journal, India, Vol. 16, Part 4, 1221.

5. Experiments with Wet Rice in Krian—H. W. Jack—Agricultural Bulletin, F.M.S, Vol. VII, No. 5, 1919.

(To be continued).

*REPORT ON "BLACK FRUIT" DISEASE OF PEPPER VINES IN SARAWAK.

By A. Sharples.

A visit to Kuching was arranged on a request from His Highness the Rajah of Sarawak for the "services of a Mycologist to advise as to the best means of dealing with a disease which threatens to destroy the pepper gardens of the country." I arrived in Kuching on 19-9-22, and immediate arrangements were made for me to visit diseased pepper gardens in the district easiest of access from Kuching.

General data.

A few details regarding the general aspects of the pepper industry to-day and in the past will be of importance in connection with my later remarks. In his first letter on this subject H.H. the Rajah says. "As you are probably aware the pepper industry has always been one of the mainstays of the State, but within the past fifteen years production has seriously decreased owing to a disease the origin of which, and the remedies necessary to eradicate it, are beyond the knowledge of the local planters."

This statement cannot be described as exaggerated when the true position is realised. The following figures are of considerable interest.

Year.	Quantity Exported.	Value.
1877	30 piculs	$ 358
1880	350 ,,	3,850
1885	6,578 ,,	121,997
1890	16,834 ,,	237,476
1901	37,016 ,,	1,447,499
1902	47,422 ,,	2,205,762
1903	59,342 ,,	2,733,301
1904	63,616 ,,	2,611,478
1905	74,584 ,,	2,638,414
1906	90,477 ,,	2,894,278
1910	61,408 ,,	1,531,246
1920	18,031 ,,	712,122

The table shows that pepper planting was first seriously taken up between 1880 and 1885. Direct Government encouragement was primarily responsible for the large relative increases in area brought under pepper cultivation between 1880 and 1890.

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* Published by kind permission of the Sarawak Government.

The terms of this proclamation were published in 1876 and one clause was "Free passages to Planters and Coolies from Singapore." It is probable that this proclamation was directly induced by the successful cultivation in Singapore and with the failure of the pepper industry in Singapore about 1896 the benefits derived from the forward policy adopted by the Sarawak administration is directly reflected in the figures given which show the tremendous increase in value between 1890—1901.

The position is succinctly stated by a local gentleman, "When the bubble burst in 1906, (in Sarawak), many planters were ruined, gardens were abandoned and disease became rife through the plantations. The disease of "Black Berries" is to-day mainly responsible for the rapid decline of exports ; it is considered incurable *but nothing has been done to stop its spread.*"

Reasons for failure in Singapore.

Ridley (1) gives many interesting details regarding the cultivation of Pepper, but the failure in Singapore of Pepper cultivation is the only item of immediate importance in connection with my observations in Sarawak. I quote from page 293 of (1) "In Singapore pepper cultivation seems to have been started by an energetic Chinaman in 1825.....The cultivation soon increased and continued a prominent feature of the country till about 1896, when partly from the low price ; and partly from the exhaustion of firewood for cooking the gambir (pepper cultivation was usually combined with gambir cultivation) and making burnt earth for the pepper, and also of suitable timber for pepper posts, both the gambir and pepper plantations dwindled away, and in 1906 hardly one was left. During this period the area under pepper and gambir was very large and almost the whole of the original forest of the island was destroyed to make way for the two plants. After the abandonment of the ground, it became covered with lallang grass, and eventually with secondary scrub, *and was valueless for many years.*"

Ridley does not record any disease which was of importance in accelerating the failure of the crop in Singapore.

Botanical General Information.

A few notes are necessary as to the main Botanical features of the Pepper Vines. Ridley records many varieties under cultivation but in the wild state the true pepper *Piper Nigrum* L. is a woody climber attaining a considerable length. The stem is flexuous and at the nodes, numerous short roots are produced by means of which the vine clings to its support. In the wild forms it is stated that the plant is unisexual, having only male flowers or female flowers on each vine, but in the cultivated forms the spikes are usually hermaphrodite, having male elements (stamens, which contain the pollen) alongside the female elements (pistil). The presence and abundance

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1 Ridley, H. N.—Spices—1912. Macmillan & Co., Ltd.

of stamens in the flowering spikes is of the utmost importance to the planter, for if the supply of pollen is not sufficient the spikes will be partly sterile and the crop of pepper small.

Remarks on Cultivation in Sarawak.

During my visit of inspection in Sarawak I saw little to support Ridley's paragraph on Page 254 as follows:—"The necessity for protecting roots in the open fields against excessive sun heat by covering the ground with cut grass, or the refuse gambir leaves, and the healthier appearance of vines grown under light shade, among fruit trees and the like, also evidence the fact that pepper does not like continuous and excessive heat and dryness." No shade was used in any of the gardens I saw in Sarawak except where rubber had been interplanted and in these cases both the rubber and pepper were usually poor. The young gardens I inspected showed no signs of having had their roots shaded from the sun by leaf refuse though the young cuttings require shade until they commence to shoot. Similar results might be brought about, however, by the early mounding of earth over the roots, and the local atmospheric conditions might render shade treatment unnecessary.

Use of burnt earth in pepper gardens.

To one previously unacquainted with pepper cultivation the system of burning earth and using this continuously to refresh the soil around the vines is a striking feature. Low scrub, bushes, boughs of trees are cut and partly dried in the sun. A quantity is laid on the ground and covered with soil, adding alternately more branches and more soil until a good sized pile is made. The wood is ignited and allowed to smoulder for some days or even weeks, until the vegetable matter is charred. After cooling it is applied to the vines, 3 times a year, until the plant is in bearing—about 2 years old.

The results obtained by adopting this procedure as usually explained by the exceptional response made by the pepper vines to potash salts, derived from the burnt vegetation. It is probable that partial sterilisation (as showed by Russell and his co-workers) of the soil by heating may be of considerable importance. However, in Sarawak, the use of burnt earth is of primary importance, for the local Chinese cultivator leaves his pepper garden when the supply of wood for burning earth is finished; further, land otherwise suitable for pepper growing, is not utilised if there is not a suitable and convenient jungle reserve from which to obtain wood for burning.

These lengthy preliminary remarks are necessary for these will have to be considered when dealing with measures to be adopted in order to place pepper cultivation in Sarawak on its feet again.

Visits to Pepper gardens around Bau.

I reached Kuching on 19-9-22 and arrangements were made for me by the O.A.G. to visit the pepper gardens around Bau, some 25 miles from Kuching. With the energetic help of the D.O., I made visits to several gardens around Bau.

Cause.

The first garden we visited on the Jambusan Poak Road was badly diseased. The pepper vines were fruiting freely, but many of the individual spikes bore only mummified berries. Earlier stages showed small, black spots on practically ripe, mature fruits; these black spots showed the presence of golden-yellow tufts typical of the parasitic Alga—*Cephaleuros mycoidea* (Karstem), with which organism I was well acquainted as a result of investigating its effect on Rubber and Keruing (Dipterocarpus sp.). This organism has been long known as the cause of a serious disease on Tea and also on Clove plantations.

I judged that this organism was of prime importance in initiating the "Black Fruit" disease on Pepper, but maintained an open mind as to the possibility of other destructive agencies completing the work. However, work on completely mummified berries, strongly supported the view that *Cephaleurous mycoidea* (Kars) is responsible for the whole of the symptoms observed.

C. Mycoidea on other hosts.

This algae is of interest as being, in the opinion of competent observers, the most serious blight caused by cryptogams (non-flowering plants), to which Tea is subject in N.E. India. The symptoms observed on Tea are usually described under the common name of "Red Rust."

The alga is widely distributed throughout tropical Asia, Africa and America, and is found on numerous host plants.

Butler (1) says "In the Calcutta Botanic Gardens alone, it has been found on twenty species belonging to the most diverse families, from ferns to forest trees and garden flowers. A complete list of hosts in India would probably exceed a hundred and it is somewhat remarkable that, so far (in India) only one other plant of economic importance, the mango, has been found to suffer from its attack in this country." He further records that Liberian coffee is, however, sometimes injured by a very similar or even identical Alga in Java and elsewhere and it has been recently found attacking cacao twigs in the Belgian Congo, producing a serious disease of the same type as that in Tea.

C. Mycoidea on Cloves.

Ridley (loc cit) says that this Alga is a very troublesome and destructive pest on cloves, and that it is known as a destructive parasite on many kinds of thick-leaved trees in the Straits Settlements, Malay Islands, and Ceylon. It attacks among other trees, Camellias and Mangosteens. A record of some interest is that of a clove tree growing under a large Para rubber tree that was but little damaged, though the parasite was present. Ridley puts forward the view with reference to cloves, *i.e.* "I am inclined to think that the actual shading of the tree has more to do with the check of the pest, as young seedlings planted under shade in lines in a wood partly cleared for the clove plant seen quite free from the disease."

Method of attack of C. Mycoidea on Tea as compared with Pepper.

On many plants on which *C. Mycoidea* has been fouud, it occurs as a simple epiphyte, growing on the surface only and not penetrating the leaf tissues. This is well exemplified on Rubber. Not infrequently, however, the present species penetrates the leaf cuticle, and in some penetrates the whole tissue. The form on coffee in Java occurs on the young berries as well as the leaves, some of the filaments penetrating the tissues of the fruit, though the majority remain superficial. Finally in its most serious form, the alga attacks the young woody shoots, which become cankered and are killed. It is only in this form that it is really a destructive parasite, tea and mango being the most completely studied cases, though the stems of other plants, are not infrequently attacked.

My visit to Sarawak provided the first record of *C. mycoidea* (or closely allied species) as the cause of a serious disease on Pepper Vines cultivation. My observations indicate considerable differences as between its mode of attack on Tea, etc. and Pepper. As my v sit was not of long duration, I am not prepared to try to explain these differences but on Pepper Vines, the disease is almost purely a fruit disease; it is difficult to find any trace of *C. mycoidea* on young vigorous vines up to time of flowering, $1\frac{1}{2}$--2 years. The Alga is seldom found on the leaves or stems of vigorous plants although the fruits may be badly affected—the only record I made, after considerable search, was to find the leaf stalks attacked on Vines growing under slight shade provided by Rubber trees.

Symptoms.

The fruiting spikes set normally, but after a time the berries at the free end turn black, shrivel and some fall off. At this stage, the remainder of the practically ripe berries, will show small black spots, which under a hand-lens, show minute golden tufts, typical of *Cephaleuros mycoidea*. These appear superficial at this stage, but the disease progresses, and berries about the middle of the spike shrivel and turn black. In the final stages the whole of the berries on the spike become involved; most fall to the ground, but usually a few mummified berries still remain attached to the blackened spike.

Previous work on this disease-causing organism led me to consider the probability of a secondary organism getting in through the superficial lesions caused in the early stages by *C. Mycoidea*, and completing the work of mummification. Specimens were taken down to Kuching for observation in the laboratory. The only result of culturing completely mummified berries was to obtain beautiful growths of this Alga—the results were so striking as to suggest that the mummified berries could be considered as Sclerotia of *C. mycoidea*. The formation of such bodies would add difficulty to the question of

control, for it would enable the organism to persist in time, for a much longer period and would involve the collection of all such diseased berries.

The final result is not only a large absolute loss of crop but also a large loss of the more valuable white pepper. The internal part of diseased berries even when they remain on the spike are blackened throughout and are useless for white pepper production.

Control.

Previous investigations do not aid much in pointing the way to control methods, as in no case can the action of the parasite on other hosts be compared with its work on pepper vines. There is only one record I have been able to find regarding *C. mycoidea* causing a fruit disease, *i.e.* on Liberian coffee, and I cannot obtain information regarding methods of control on this crop.

As stated in my preliminary report two main lines are open.

(a) Spraying methods.

(b) General Agricultural Organisation with a possibility of a combination of (*a*) and (*b*).

Remarks on Spraying Methods.

In my first report I stated that I viewed spraying methods with some reluctance. This attitude I adopted more firmly after I visited Bau to carry out preliminary spraying trials. All the present conditions in Sarawak are against successful spraying. The pepper gardens are small in extent and fairly widely separated and there is no easy communication. A clean water supply is essential for the mixing of the usual spraying mixtures, otherwise the nozzles, which must have an exceedingly small opening to be effective are constantly choked. This results in considerable loss of time and materials. Moreover the difficulty of making up Copper or Lime-Sulphur sprays renders their recommendation unadvisable under the existing conditions.

As matters stand the only hope for spraying is to utilise some of the patent proprietary Coal-Tar fungicides, soluble in water. In my preliminary experiments I used "Agrisol" in $2\frac{1}{2}\%$ solution. This solution sprayed quickly and effectively without choking the nozzle; its fungicidal action, however, is still to be tested. Other proprietary fungicides, miscible in water, such as Izal, Brunolinum Plantarium might be tried experimentally on a small scale. Any spraying operation such as recommended above, should be carried out with discretion, as there is some possibility of severe damage to the vines, if the mixture is not suitable.

Agricultural Organisation.

It is obvious that spraying measures cannot be recommended even experimentally without reservation. With a properly qualified

Agricultural expert to supervise, spraying experiments might be devised and results obtained which would help the general control to a considerable extent. Thus the position at present can only be improved by setting up machinery to initiate Agricultural organisation, with a view to accelerating general sanitation in the agricultural pursuits of the country.

I might say at this point that local experience might considerably influence recommendations as regards organisation. As my visit was only of short duration the following remarks, therefore, can only be regarded as suggestive; local conditions may render imperative the need for modification. The main lines I recommend will, however, be clear enough.

Healthy appearance of young vigorous vines.

In connection with the "Black Fruit" disease, a striking feature is the absence of *C. mycoidea*, up to the time of the flowering spikes appearing, some 18 months—2 years. A case was observed however, where in a pepper garden vines 5 years old, showed no signs of flowering and were less developed than those in a neighbouring garden of 18 months. This backward garden might be a case of degenerate stock owing to continued planting from cutings, but this degeneracy of stocks has little to do with the "Black Fruit" disease, for the berries on the finest looking vines are as badly affected as those on a badly grown vine. Thus the question of degenerate stock can be held in abeyance which aids considerably in the consideration of immediate control.

Attention has already been drawn to the question of forest reserve influencing the position and tenure of pepper gardens. Once the supply of wood for burning earth is finished the pepper planter must migrate to a fresh area, leaving his probably, badly infected garden just as it stands. This is the first step to be considered. Is the pepper planter forced to migrate, or cannot some method be adopted by which he could remain permanently in one spot? If no measures can be introduced to keep the land given out for pepper under permanent cultivation, and migration is enforced by lack of supplies of timber for burning, all the pepper vines, and posts should be uprooted, the vines burnt and the *belian* poles if still usable should be well disinfected and transferred. It may be cheaper and more convenient of course, to add the poles to the bonfire.

Thus when land is given out for pepper cultivation, a clause for destruction of all old vines etc. in the case of the site being abandoned, should be enforced under strict penalty. As the gardens are usually small, such a clause would not entail and hardship.

The limiting factor for the pepper gardens is wood for burnt earth. As the forest reserve is denuded of its wood could not some quick growing tree, suitable for fuel be planted and the reserve thus restocked with wood grown specially for burning purposes? The Conservator of Forests, would probably be much interested in this proposition. I suggest as suitable trees for experiment, *Grevillea*

robusta, *Albizzia moluccana*, *Cassia Siamea*, *Michelia Champaca*. I am fairly confident that something in this line can be done and thus not only prevent the abandonment of pepper gardens and this land becoming useless, but prevent waste of large areas of forest land. I think this would prove the most profitable line in the immediate control of "Black Fruit" disease, for if careful site selection were undertaken at the inception of a pepper garden, so that a fairly clean water supply was at hand spraying measures would possibly be undertaken with success. The immediate benefit would be in stopping the exodus from gardens on immaterial grounds and a consequent large reduction in the number of gardens abandoned. It is these abandoned gardens which act as centres of infection and as long as present methods are in vogue new gardens will certainly become infected. Could the wood supplies be made permanent along some such line as suggested, the control of "Black Fruit" disease is practically ensured. Healthy pepper vines produce profitably for 12—14 years (according to my information) and there seems no reason why the land should be abandoned when the vines need renewal, more especially as the soil is continually refreshed by applications of burnt earth. With a permanent area of artificially restocked jungle for burning purposes, situated conveniently, land once given out for pepper growing should remain under permanent or almost permanent cultivation.

Question of abandoned Rubber.

Abandoned rubber holdings are only too noticable in Sarawak. The presence of abandoned rubber is of importance because *C. mycoidea* is epiphytic on rubber leaves, more especially on rubber trees under bad conditions of cultivation. The question of abandoned rubber will have to be considered in general sanitation measures, for such will act as centres of infection just as efficiently as abandoned pepper gardens.

The problem presented in Sarawak could only be effectually dealt with by experts on the spot, and although I have gone to some length to indicate lines of quickest progress, every stage will have to be studied carefully.

I do not think it advisable to go into greater detail, as for instance to give formulas for spraying mixtures, for I do not consider for a moment that a non-technical officer could possibly appreciate the difficulties inherent in all disease control. To put effective measures into operation the appointment of agricultural officers is a necessity. I would suggest a Chief Agricultural Officer or Director with special knowledge of disease research be appointed as soon as possible to be supplemented later by the appointment of an Assistant Chemist. Two officers of good experience should be able to tackle the pepper disease and reduce losses to negligible proportions, unless prolonged experience of "Black Fruit" disease on pepper, shows complications which I did not appreciate during my short visit. Personally I do not except any complications which would render it necessary for me to modify my opinion—that "Black Fruit" disease on pepper could be reduced, *not eradicated*, to negligible proportions. Care would always be necessary, but only in cases of neglect is there reason to expect serious loss.

The appointment of two Agricultural officers as suggested would result in much improvement in other directions. The agricultural pursuits noted on my visit, padi, coconuts, rubber, would all be improved by expert advice and much improvement might be expected in those crops.

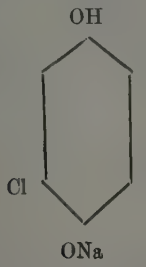
In conclusion, I must record my indebtness to the Resident Kuching, Mr. A. B. Ward for his endeavours to accelerate all my requests during my visit. To Mr. F. H. Kortright, District Officer, Upper Sarawak I offer my appreciation of his hospitality and it is largely owing to his keen and energetic direction that I was enabled to see as much as I did during a limited stay.

DICHLORHYDROQUINONE AS A PREVENTATIVE OF SPOT DISEASE ON RUBBER.

By R. O. Bishop and V. R. Greenstreet.

A sample of a chemical reputed to be a preventative of spot disease on rubber was received from Mr. Edwards M.C., Chemist to the Rubber Growers' Association Malaya for examination.

It was identified as the sodium salt of one of the dichlorhydroquinones probably a commercial form of the 2:5 symmetrical compound :—



Experimental:—Experiments to prove its efficacy were subsequently carried out. A four per cent aqueous solution was prepared and samples of rubber treated with it in the following manner. Each sample was prepared from three quarters of a gallon of bulked latex and coagulated with three ounces of a 5 per cent acetic acid solution.

In the first experiment the solution of the chemical was added to the latex and crepe and slab rubber were prepared from the coagulum. In the case of the slab, this was allowed to mature for one week before crepeing. After crepeing and drying all the samples were dipped in water, rolled up loosely and stored for three months, after which they were dried before mixing, preparatory to vulcanisation.

In a second experiment the samples of crepe were soaked in the solution of the chemical for 6 hours, after which they were dried at 50°C. The samples were then spotted with water, rolled loosely and stored in a dry cupboard for three months.

Control samples of slab and crepe were prepared and treated in the same manner, except that they were not treated with the chemical.

The following table gives the results obtained :—

EXPERIMENT I.

Sample No.	Ref No.	Type of Rubber.	Treatment.	Results.
1	192Ac	Crepe	Control	Very mouldy
2	192Ec	Crepe	0.5 per cent solution of chemical added	Traces of mould
3	192Bc	Crepe	1 per cent solution of chemical added	No mould

Sample No.	Ref No.	Type of Rubber.	Treatment.	Results.
4	192As	Slab	Control	Mouldy
5	192Es	Slab	0.5 per cent solution of chemical added	No mould
6	192Bs	Slab	1 per cent solution of chemical added	No mould

EXPERIMENT II.

Sample No.	Ref No.	Type of Rubber.	Treatment.	Results.
7	192Cs	Slab	Control dry	No mould
8	192Cc	Crepe	Control dry	Mouldy
9	192Dc	Crepe	Control spotted with water	Very Mouldy
10	192Dco	Crepe	Soaked in solution of chemical then spotted with water	Mouldy
11	192X	Bark Scrap crepe	Control spotted with water	Mouldy
12	192V	Bark Scrap crepe	Soaked in solution of chemical then spotted with water	No mould

The samples of rubber were then vulcanised, using a mixing of 90 parts of rubber to 10 parts of sulphur with the result shown in the table below :—

No.	Type of Rubber.	Optimum time of cure from tensile curve. (minutes)	Optimum time of cure giving maximum tensile strength (minutes)	Breaking load (kilos per sq. mm)	Elongation at break (original length = 100)	Tensile product
				(a)	(b)	(a × b)
1	Crepe	150	120	1.06	1065	1128
2	Crepe	150	150	1.31	1025	1342
3	Crepe	150	120	0.86	1000	860
4	Slab	80	75	1.38	1045	1442
5	Slab	80	70	1.42	1091	1549
6	Slab	80	75	1.12	1016	1137
7	Slab	80	75	1.28	1030	1318
8	Crepe	150	120	1.01	1027	1037
9	Crepe	180	180	0.98	1025	1007
10	Crepe	180	180	1.02	978	997
11	Bark Crepe	165	165	0.85	923	784
12	Bark Crepe	165	165	0.83	885	734

Remarks and conclusions :—These results show that dichlorhydroquinone is efficacious in preventing the formation of mould in crepe rubber. An amount equivalent to 35 cubic centimetres of a 4 per cent solution on three quarters of a gallon of latex containing 15 per cent of rubber is sufficient, when added to the latex direct. This is equivalent approximately to 0.27 per cent of sodium dichlorhydroquinone on the dry rubber or about 6 ozs of the pure chemical per 100 gallons of latex containing 1½ lbs. of rubber per gallon. By soaking crepe rubber in the solution, mould growth is not prevented to the same extent, although it may be retarded. The amount of antiseptic necessary to prevent mould growth does not interfere with the normal maturation of slab rubber. These small quantities of the chemical do not appear to affect either the tensile properties or the rate of vulcanisation of the rubber. It is understood that a similar substance is on the market under the name of "Mouldicide."

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OIL CAKES.

As Feeding-Stuffs for Cattle.

THE following is an abstract of information contained in a report presented at the Congress of Colonial Production by Professor Dechambre and published in Bulletin des Matieres Grasses de l'Institute Colonial de Marseille (Nos, 11 & 12, 1922). Emphasis is laid on the value of oil cakes as cattle food which is well known to French cattle breeders. Attention is drawn to the economic advantages gained by the use of oil cakes and the results obtained. The value of oil cakes in increasing the yields of individual animals in respect of production of milk, meat or of work is also pointed out.

All farm animals including young, stock for breeding purposes, cattle for milk or fattening, draught animals and poultry can be fed on oil cakes as a supplementary diet.

In order to obtain the most satisfactory results, it is necessary however to work out carefully for each type of animal, the kind of cake most suited to its requirements. its preparation and the amount of ration. The satisfactory feeding of and the provision of a liberal diet to the mother during the period of gestation is of considerable influence on the development of the young and ensures an abundant secretion of milk. The rate of development of the young animal is also influenced considerably by the diet provided after the suckling period.

Experiments on pigs, which respond well to the influence of a proper diet furnish valuable data. Figures are quoted in support of this statement.

Defects due to poor early development owing to bad feeding also persist at a later stage of growth. Oil cakes are extremely useful, as they enable the farmer to provide his breeding stock animals with a complete diet.

Experiments on calves carried out by the Department of Agriculture Areige have demonstrated the value of copra cake as a feeding stuff at the time of weaning and subsequently.

Trials with young pigs fed in the usual way on Sorghum shew that groundnut cakes, provided in the proportion of 20 per cent of the weight of the Sorghum ration, enabled the pigs to get over the weaning period without any check in growth or organic development.

A suitable daily ration consisted of Sorghum 1200 grams (2.6 lbs.) bran—400 grams (0.9 lb.) and groundnut cake 300 grams (0.7 lb.), given in three meals.

Oil cakes are also invaluable during a scarcity of food stuffs and during hard times to prevent forced sales at falling prices.

Cows can be maintained by means of a ration of straw or coarse forage together with oil cake. The straw should be cut up and macerated with the oil cake to form a suitable mash. Beneficial results have been obtained by using a mixture of maize and oil cake as a ration for cows in milk.

As a result of experiments by the Director of Agriculture, Gironde, on pigs, it has been shewn that it is possible economically to raise the weight of pigs with a diet of water, groundnut cake and palm kernel cake.

Oil cakes alone or mixed with other foods can also be used for poultry feeding. Palm kernel cake is suitable for breeding or fattening purposes. The following formula is recommended for laying birds :—

Fish meal 20 parts, mashed nettles 20 parts, crushed oyster shells 7 parts, small grit 3 parts, ground nut cake 30 parts and palm kernel cake 20 parts. The nettles are cut up finely and soaked, before being mixed with the other ingredients.

Copra cake has given good results with rabbits and is equally suitable for fattening ducks, geese, turkeys and fowls. It imparts no objectionable taste to the flesh.

The above information and many other experiments have thoroughly demonstrated the value of oil cakes as a feeding-stuff. In Malaya, both copra cake and ground nut cake are available but, owing to the comparatively small number of cattle, poultry and pigs, most of the cake is exported from the country.

An investigation of local food-stuffs for poultry is being carried out by the Chemical Division of the Department of Agriculture.

B. J. E.

Received for publication March 12th 1923.

CANDLE NUT OIL

From Aleurites Moluccana.

THE following information in respect of markets for Candle nut oil has been received as a result of enquiries made by the Department.

(1) Large quantities of Chinese Wood oil are sold in England for paint and varnish manufacture. The bulk of the Hankow oil is from *Aleurites Fordii* while that from Canton is chiefly from *A. Montana*.

The oil from the Japanese variety, *Aleurites Cordata*, is also found on the market. The principal property of these oils is that they polymerise and form suitable films when treated by certain methods and their value in paint and varnish manufacture is due largely to this property.

Candle nut oil from *A. Moluccana*, although closely related to Chinese Wood oil does not polymerise in this way and is therefore not suitable as a substitute. It can however be used in paint and varnish manufacture, but there appears to be no definite market in England for large quantities. This however is probably due to the fact that hitherto large quantities have not been available regularly and buyers will not go to the trouble of experimenting with small lots or fix contracts binding them to take an oil which has not a definite market value.

The oil cake cannot be used for cattle feeding and it is therefore preferable to export oil rather than kernels. In any case the export of the whole nut is not economical on account of freight charges. A large firm of oil mill machinery manufacturers in England states that there should be no difficulty in disposing of any quantity of the oil. Hitherto the oil has not been used to any appreciable extent and the successful marketing of the oil will depend to a considerable extent on the price at which the oil can be sold.

Firms to whom enquiries were addressed however require samples for trial and suggest that a consignment of about a ton be placed on the market. One firm considers that it will probably not be a practicable proposition to shell the nuts and export the kernels and that it will probably be preferable to express the seeds on the spot.

Further, if the kernels are broken during shelling the quality of the oil may be deteriorated.

The Director of the Imperial Institute considers, as a result of enquiries, that the oil would probably realise about two-thirds the price of linseed oil, which is at present (March 1923) about £40/ per ton. The dry kernels should realise about three-quarters the

price of linseed. The principal market at present is in America, which imports the oil from the Philippines under the name of "lumbang" oil.

In 1918, 184 tons of the oil valued at $65,000/- gold were shipped from the Philippines and a much larger quantity could be absorbed by the American market. The shipping of whole nuts would not be remunerative but the export of the kernels might be profitable.

The Director of the Bureau of Science, Manila has been good enough to supply the following information :—

"Lumbang oil is one of the many vegetable oils found ordinarily "in the U.S. markets. Quotations of prices are given in "Oil, Paint "and Dry Reporter," 100 William Street, New York. In May— "June, 1922 the price was $0.10—$0.105 per lb. The oil is ex- "pressed locally, partly for export, but mostly for home consumption. "Nuts or kernels are not exported, but could be handled like copra. "The tree grows abundantly in the wild state in the Philippines and "the Government is encouraging the planting of the tree, but there "are no large plantations yet."

B.J.E.

Received for publication 17th April 1923.

RESUME OF AN ADDRESS MADE BY MR. A. CAVENDISH,

Officer in Charge of Co-Operative Societies at the Conference of the Malay Officers* of the Agricultural and Co-Operative Departments held on Monday November 20th, 1922, at Kuala Lumpur.

THE Conference marked a new stage in the development of Agriculture in this country in so far as it was the first appearance of the Officers of the Co-operative Department. Mr. Cavendish emphasised the necessity of the very closest co-operation between the Officers of the Agricultural Department and those of the Co-operative Department. The work of the Agricultural Department was directed rather towards the scientific and technical side of agriculture whereas the Co-operative Department was concerned more with the economic side. Hitherto practically no attention had been paid to the economic side. He quoted the words of Sir Leslie Scott, Chairman of the Agricultural Organisation Society in England which bear upon the present position in Malaya, and which he varied to suit the local conditions :--

> "Planters do not plant for patriotism or for fun ; they plant to make a living for themselves and their families.....It is no use to preach to planters how they should plant unless you can tell them at the same time how they can plant at a profit."

The need for closer co-operation of the work of the Agricultural and Co-operative Departments and the necessity to investigate thoroughly the economic side of agriculture was also brought out in certain passages from Mr. Cavendish's report of August 1921 giving a brief account of the system of Co-operation in Burma with certain recommendations for introducing the system of Co-operation into Malaya, and Mr. Eaton's report on Agriculture for the year 1921 published in 1922. The following extracts from his reports on co-operation was quoted :—

(i) "The Agricultural Department should cover a much wider field of operations than it has done in the past. It should use the service of co-operative societies for the dissemination of agricultural improvements, the supply of seed of purer strain or of improved varieties and the introduction of improved machinery and implements ; and generally assist the co-operative purchase and sale of agricultural supplies and products of societies. The advice and assistance of the Agricultural Department should be readily available for such work as the grading and marketing of produce of agricultural societies where expert opinion is essential. The societies should not, however, be used for experimenting in new processes but for popularising proved improvements. Periodical conferences arranged by the Agricultural and Co-operative

*(Many European Officers were also present)

Departments should be held—possibly and preferably whenever agricultural shows take place in different places."

Mr. Eaton in his report wrote :—

(ii) "Another desirable function of a Department of Agriculture which has not received due attention in the past, chiefly owing to lack of staff, is the question of agricultural economics, in respect of markets, co-operation among small holders for transport facilities or local purchase of produce for export, and machinery for the treatment of certain crops for the market. The proposed formation of Co-operative Societies working in conjunction with the department should be of considerable value in this connection.

"At present information is available on many crops which can be grown in Malaya, but unfortunately is lacking in respect of costs of production, including cost of planting, cultivating and harvesting and preparation for the market. These factors which must be known in estimating the probable profits to be derived from any crops are receiving attention in connection with the cultivation of new crops at the Experimental Plantations, Serdang.

"It is not possible nor desirable for the Department, except to a limited extent, to become purchasers of produce, but it should be able to render useful assistance by placing producers in touch with probable buyers and keeping in touch with the market value of agricultural products.

"Lack of staff in the past and the lack of any suitable large scale plantation, which has resulted in the dissipation of energy on a number of small and unsuitable experimental plantations, has resulted in absence of knowledge of the local possibilities of crops other than rubber, coconuts and rice and a few other crops. The possibilities of any new crop can be determined only by suitable field trials carried out in many cases over several seasons in the case of annual or semi-permanent crops, owing to the number of variable factors concerned."

The development of the scientific and economic sides of Agriculture could not be left entirely to Government or to the efforts of two official departments like the Agricultural and Co-operative Departments. The practical planters must also join in the common task. The task could be most effectively performed by means of an Agricultural Organisation Society composed mainly of leading land owners of every nationality and their representatives assisted by Officials from the Agricultural and Co-operative Departments in a minority as the representatives of Government. The scheme for an Agricultural Organisation Society was more fully set out in a paper entitled "Co-operation as a subject for Study in Malaya."

It would be part of the work of an Agricultural Organisation Society to convene Agricultural and Co-operative Conferences attended not merely by a few officials of Government but also in large numbers by that section of the public interested in Agriculture. Such conferences were held periodically in India in conjunction with Agricultural shows or other big social or commercial functions. For instance the Agricultural and Co-operative Conference in Burma was attended by over 1,000 delegate of co-operative societies. It was opened by the Governor in the presence of Commissioners, Deputy Commissioners and leading officials. The Press, the leading merchants, bankers, shippers, Railway officials, millers and other prominent members of the commercial community were present and took part in the deliberations. After the opening address made by the Governor, speeches were made by the Director of Agriculture, Registrar or Co-operative Societies, Chairman of the Co-operative Bank and others on the leading events which had taken place and on the progress made since the last conference. The conference then broke up into special committees to consider the manifold issues connected with Agriculture. Questions affecting stock breeding, cattle insurance, the development of rural industries such as weaving, pottery, arts and crafts, etc., etc. were discussed and considered. The Director of Museums and Chief Veterinary Officers took part in these deliberations. Mr. Cavendish hoped that such conferences would some day be convened in Malaya and that the Malay Officers would take part in them and would not be content merely with reading papers, but would also be able to get up and express their views during the various discussions. Such conferences were of the greatest educational utility and he trusted that the officers of the Agricultural Department both European and Malay would do their best to assist the formation of an Agricultural Organisation Society which, when created, would be able to bring into being truly representative Agricultural and Co-operative Conferences.

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